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Microbiological Profile, Antimicrobial Susceptibility, and Antifungal Susceptibility Pattern of Bloodstream Infections among Intensive Care Unit Patients at a Tertiary Care Hospital

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Abstract

Background: Bloodstream infections (BSIs) are among the most severe healthcare-associated infections encountered in intensive care units (ICUs). They are associated with high morbidity, mortality, prolonged hospital stay, and increased healthcare expenditure. The emergence of multidrug-resistant microorganisms has further complicated the management of BSIs, making early microbiological diagnosis and knowledge of local antimicrobial susceptibility patterns essential for appropriate empirical therapy and effective antimicrobial stewardship.

Aim: To determine the microbiological profile and antimicrobial susceptibility pattern of bloodstream infections among clinically suspected intensive care unit patients admitted to a tertiary care hospital.

Materials and Methods: A prospective observational study was conducted in the Department of Microbiology of a tertiary care hospital over the study period. A total of 50 ICU patients clinically suspected of bloodstream infection were included. Blood samples were collected aseptically before the initiation of antimicrobial therapy whenever feasible and processed using standard microbiological techniques. Identification of bacterial and fungal isolates was carried out by conventional

microbiological methods, and antimicrobial susceptibility testing was performed in accordance with the Clinical and Laboratory Standards Institute (CLSI) guidelines.

Results: Among the 50 clinically suspected ICU patients, 6 (12%) yielded positive blood cultures, while 44 (88%) showed no microbial growth. The majority of patients belonged to the 46–60-year age group (36%), and males constituted 62% of the study population. Medical ICU contributed the highest proportion of cases (40%). Previous antibiotic exposure (84%), urinary catheterization (80%), prolonged hospital stay (70%), and central venous catheterization (60%) were the major risk factors associated with suspected bloodstream infection. Gram-negative bacteria were the predominant pathogens, accounting for 66.7% of isolates, with *Klebsiella pneumoniae* being the most frequently isolated organism (33.3%). Gram-positive bacteria and *Candida* species each constituted 16.7% of isolates. Gram-negative isolates demonstrated maximum susceptibility to Colistin (100%), followed by Meropenem, Imipenem, and Amikacin (75% each), whereas reduced susceptibility was observed for Ceftriaxone and Ciprofloxacin. The Gram-positive isolate remained susceptible to Vancomycin and Linezolid, while the *Candida* isolate was susceptible to Amphotericin B, Caspofungin, Voriconazole, and Fluconazole. Multidrug resistance was observed in 33.3% of bacterial isolates. The overall mortality among the study population was 16%.

Conclusion: Gram-negative bacilli were the predominant pathogens causing bloodstream infections among ICU patients, with Klebsiella pneumoniae being the most common isolate. Continuous microbiological surveillance, prompt blood culture testing, periodic monitoring of antimicrobial susceptibility patterns, and implementation of antimicrobial stewardship programs are essential for guiding empirical therapy, limiting the emergence of antimicrobial resistance, and improving clinical outcomes in critically ill patients.

Keywords: Bloodstream infection, Intensive Care Unit, Blood culture, Antimicrobial susceptibility, Klebsiella pneumoniae, Antimicrobial resistance, ICU, CLSI.

Introduction

Bloodstream infections (BSIs) are among the most serious healthcare-associated infections and are a major cause of morbidity and mortality, particularly in patients admitted to intensive care units (ICUs). Critically ill patients are at increased risk of developing BSIs because of impaired immunity, prolonged hospitalization, invasive procedures, mechanical ventilation, central venous catheterization, urinary catheterization, and prior exposure to broad-spectrum antibiotics. These infections are associated with prolonged hospital stay, increased healthcare costs, and poor clinical outcomes if not diagnosed and treated promptly.[1–4]

The epidemiology of bloodstream infections has evolved over the years, with Gram-negative bacteria emerging as the predominant pathogens in many tertiary care hospitals. Common causative organisms include Klebsiella pneumoniae, Escherichia coli, Acinetobacter baumannii, Pseudomonas aeruginosa, Staphylococcus aureus, coagulase-negative staphylococci, Enterococcus species, and Candida species. The distribution of these pathogens varies according to geographical region, patient population, and local infection control practices.[5–9]

The epidemiology of bloodstream infections has changed considerably over the past two decades. Earlier studies reported Gram-positive organisms as the predominant pathogens causing bloodstream infections; however, more recent studies from tertiary care hospitals,

particularly in developing countries, have demonstrated an increasing predominance of Gram-negative bacteria. This shift has been attributed to widespread antibiotic use, increased utilization of invasive medical procedures, prolonged ICU stay, and the emergence of multidrug-resistant organisms. Common Gram-negative pathogens include Klebsiella pneumoniae, Escherichia coli, Acinetobacter baumannii, and Pseudomonas aeruginosa, whereas Gram-positive organisms such as Staphylococcus aureus, coagulase-negative staphylococci, and Enterococcus species continue to be important causes of bloodstream infections. In recent years, fungal bloodstream infections caused by *Candida* species have also emerged as an important cause of healthcare-associated infections, particularly among immunocompromised patients and those receiving prolonged antimicrobial therapy.[6–10]

Blood culture remains the gold standard for the diagnosis of bloodstream infections. Isolation and identification of the causative organism, followed by antimicrobial susceptibility testing according to Clinical and Laboratory Standards Institute (CLSI) guidelines, are essential for selecting appropriate antimicrobial therapy and improving patient outcomes. Timely microbiological diagnosis also plays an important role in infection prevention and control measures within healthcare facilities.[5,10–13]

The rapid emergence of multidrug-resistant (MDR) organisms, including extended-spectrum β-lactamase (ESBL)-producing Enterobacterales, carbapenem-resistant Gram-negative bacilli, methicillin-resistant Staphylococcus aureus (MRSA), and resistant Candida species, has become a major global health concern. Inappropriate and indiscriminate use of antibiotics has accelerated antimicrobial resistance, making the treatment of bloodstream infections increasingly challenging. Continuous surveillance of antimicrobial susceptibility patterns is therefore essential for guiding empirical therapy, developing hospital antibiograms, and strengthening antimicrobial stewardship programs.[14–18]

Knowledge of the local microbiological profile and antimicrobial susceptibility pattern is crucial for the early initiation of effective treatment and reduction of mortality among ICU patients. Therefore, the present study was undertaken to determine the microbiological profile and antimicrobial susceptibility pattern of bloodstream infections among intensive care unit patients at a tertiary care hospital. The findings of this study are expected to provide valuable information for clinicians in selecting appropriate empirical antimicrobial therapy and formulating evidence-based antibiotic policies.[19,20]

Materials and Methods

Study Design

This was a hospital-based prospective observational study conducted to determine the microbiological profile and antimicrobial susceptibility pattern of bloodstream infections among intensive care unit (ICU) patients.

Study Place

The study was carried out in the Department of Microbiology in collaboration with the Intensive Care Units of a tertiary care teaching hospital.

Study Duration

The study was conducted over a period of 12 months**.**

Study Population

The study included patients admitted to various ICUs with clinical suspicion of bloodstream infection during the study period.

Sample Size

A total of 50 clinically suspected ICU patients were included in the study.

Inclusion Criteria

1. Patients admitted to Medical, Surgical, Cardiac, Neurosurgical, or Pediatric ICUs.
2. Patients of any age and either gender with clinical suspicion of bloodstream infection or sepsis.
3. Patients from whom blood culture samples were received before or within 24 hours of initiation of antimicrobial therapy, whenever feasible.
4. Patients or legally authorized representatives who provided written informed consent.

Exclusion Criteria

1. Patients who declined to participate in the study.
2. Blood culture samples that were inadequate in volume, improperly labeled, leaking, or contaminated during collection or transport.
3. Duplicate blood culture samples from the same infectious episode.
4. Patients with incomplete clinical or laboratory data.

Sample Collection

After obtaining informed consent and maintaining strict aseptic precautions, approximately 8–10 mL of blood from adults and 1–3 mL from pediatric patients was collected by peripheral venipuncture before administration of antibiotics whenever possible. Blood was inoculated immediately into blood culture bottles and transported promptly to the microbiology laboratory.

Laboratory Processing

Blood culture bottles were incubated according to standard laboratory protocols. Bottles showing evidence of microbial growth were subcultured on Blood agar and MacConkey agar. Organisms were identified based on colony morphology, Gram staining characteristics, and standard biochemical tests. Yeast isolates were identified using conventional microbiological methods.

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was performed by the Kirby–Bauer disc diffusion method on Mueller–Hinton agar following the Clinical and Laboratory Standards Institute (CLSI) guidelines (2025 edition). Results were interpreted as Sensitive, Intermediate, or Resistant according to CLSI breakpoints.

Data Collection

Demographic details, clinical characteristics, ICU type, associated risk factors, microbiological findings, antimicrobial susceptibility pattern, and clinical outcomes were recorded in a predesigned case record form.

Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software (Version 26.0). Categorical variables were expressed as frequencies and percentages. Continuous variables were expressed as mean ± standard deviation. A p-value of <0.05 was considered statistically significant.

Results

A total of 50 intensive care unit (ICU) patients with clinical suspicion of bloodstream infection were included in the study. The majority of the patients belonged to the 46–60 years age group (18, 36%), followed by 31–45 years (12, 24%), >60 years (12, 24%), and 18–30 years (8, 16%). Male patients constituted the majority of the study population, accounting for 31 (62%) cases, while 19 (38%) were females, with a male-to-female ratio of approximately 1.6:1.

Among the various intensive care units, the highest number of patients were admitted to the Medical ICU (20, 40%), followed by the Surgical ICU (12, 24%), Neurosurgical ICU (8, 16%), Cardiac ICU (5, 10%), and Pediatric ICU (5, 10%).

The most common clinical presentation was fever, which was observed in 46 (92%) patients. Tachycardia was present in 34 (68%), chills and rigors in 29 (58%), hypotension in 18 (36%), altered sensorium in 15 (30%), and septic shock in 9 (18%) patients. Analysis of associated risk factors revealed that previous antibiotic exposure was the most common predisposing factor, present in 42 (84%) patients. Urinary catheterization was observed in 40 (80%), prolonged hospital stay (>7 days) in 35 (70%), central venous catheterization in 30 (60%), mechanical ventilation in 28 (56%), diabetes mellitus in 17 (34%), and chronic kidney disease in 8 (16%) patients.

Table 1. Age-wise Distribution: A total of 50 patients clinically suspected of bloodstream infection were included. The largest proportion of patients belonged to the 46–60-year age group (36%), followed by 31–45 years (24%), patients older than 60 years (24%), and 18–30 years (16%). This suggests that middle-aged and elderly individuals constituted the majority of ICU admissions with suspected bloodstream infections, probably because of multiple comorbidities and increased exposure to invasive procedures.

Table 1: Age-wise Distribution of Study Participants (n = 50)

Age group (years)	Number (n)	Percentage (%)
18–30	8	16.0
31–45	12	24.0
46–60	18	36.0
>60	12	24.0
Total	50	100.0

Of the 50 patients, 31 (62%) were males and 19 (38%) were females, giving a male-to-female ratio of approximately 1.6:1. The predominance of male patients may reflect higher ICU admission rates and a greater burden of severe systemic illnesses among males.

Table 2: Gender-wise Distribution

Gender	Number (n)	Percentage (%)
Male	31	62.0
Female	19	38.0
Total	50	100.0

Table 3: ICU-wise Distribution

ICU	Number (n)	Percentage (%)
Medical ICU	20	40.0
Surgical ICU	12	24.0
Neurosurgical ICU	8	16.0

Cardiac ICU	5	10.0
Pediatric ICU	5	10.0
Total	50	100.0

Medical ICU contributed the highest number of patients (40%), followed by Surgical ICU (24%), Neurosurgical ICU (16%), Cardiac ICU (10%), and Pediatric ICU (10%). This distribution indicates that critically ill medical patients constituted the major population evaluated for bloodstream infections.

Table 4: Clinical Presentation

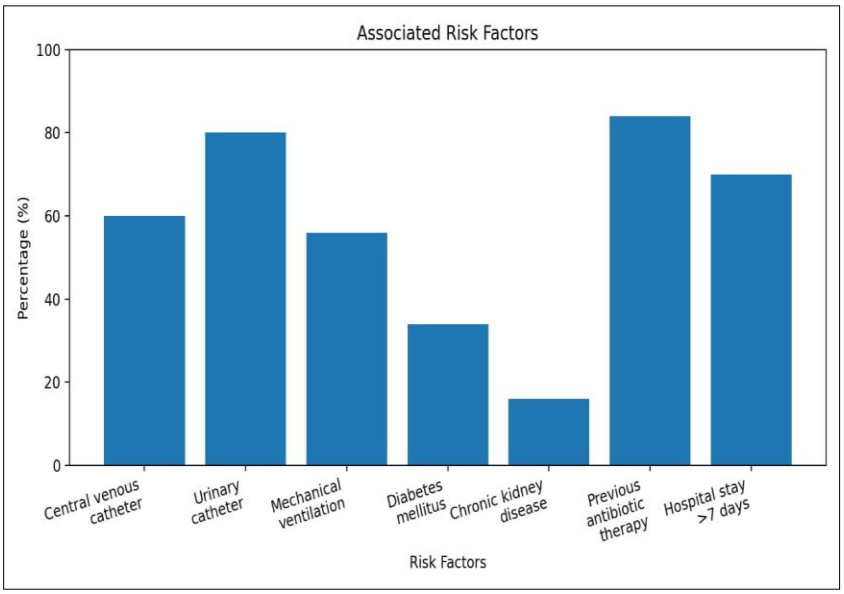
Clinical feature	Number (n)	Percentage (%)
Fever	46	92.0
Chills/Rigors	29	58.0
Hypotension	18	36.0
Tachycardia	34	68.0
Altered sensorium	15	30.0
Septic shock	9	18.0

Fever was the most common presenting symptom, observed in 92% of patients. Tachycardia occurred in 68%, chills and rigors in 58%, hypotension in 36%, altered sensorium in 30%, and septic shock in 18% of cases. These findings demonstrate that fever and systemic inflammatory response remain the predominant clinical indicators prompting blood culture investigations in ICU patients.

Table 5: Associated Risk Factors

Risk factor	Number (n)	Percentage (%)
Central venous catheter	30	60.0
Urinary catheter	40	80.0
Mechanical ventilation	28	56.0
Diabetes mellitus	17	34.0
Chronic kidney disease	8	16.0
Previous antibiotic therapy	42	84.0
Hospital stay >7 days	35	70.0

Previous antibiotic therapy was identified in 84% of patients, making it the most common predisposing factor. Urinary catheterization was present in 80%, prolonged hospitalization in 70%, central venous catheterization in 60%, mechanical ventilation in 56%, diabetes mellitus in 34%, and chronic kidney disease in 16% of patients. These observations highlight the contribution of invasive devices and prolonged hospital exposure to the development of suspected bloodstream infections.



Graph 1: Associated Risk Factors

Table 6: Blood Culture Results

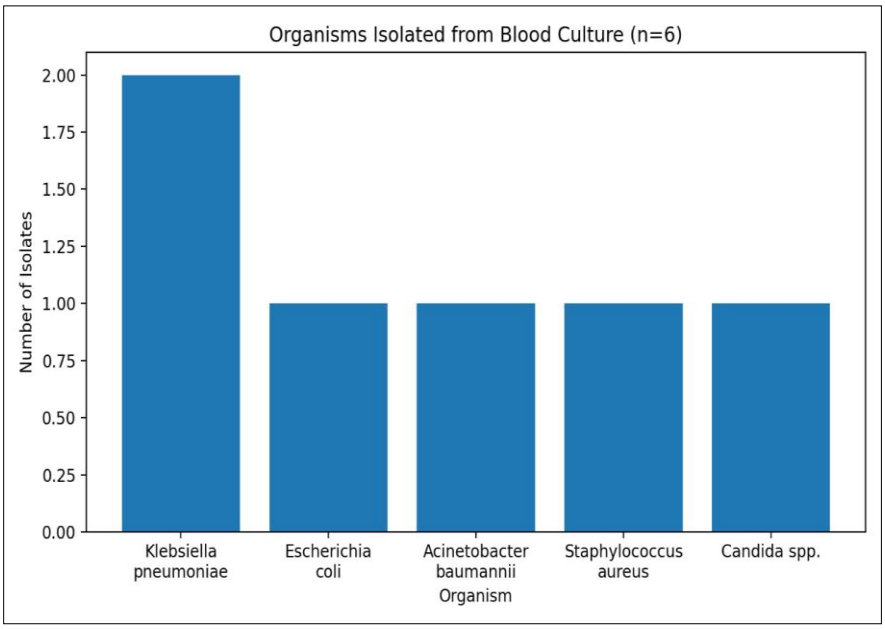
Blood culture	Number (n)	Percentage (%)
Positive	6	12.0
Negative	44	88.0
Total	50	100.0

Out of 50 blood samples processed, only 6 (12%) yielded significant microbial growth, while 44 (88%) remained sterile. The relatively low positivity rate may be attributed to prior antibiotic administration, inadequate bacteremia at the time of sampling, or infections caused by fastidious organisms not recovered by routine culture methods.

Table 7: Organisms Isolated from Blood Culture (n = 6)

Organism	Number (n)	Percentage (%)
Klebsiella pneumoniae	2	33.3
Escherichia coli	1	16.7
Acinetobacter baumannii	1	16.7
Staphylococcus aureus	1	16.7
Candida spp.	1	16.7
Total	6	100.0

Among the six positive blood cultures, Klebsiella pneumoniae was the most frequently isolated pathogen (33.3%), followed *by* Escherichia coli*,* Acinetobacter baumannii*,* Staphylococcus aureus*,* and Candida species, each accounting for 16.7%. The predominance of Gram-negative organisms reflects the changing epidemiology of bloodstream infections in ICUs.



Graph 2: Organisms Isolated from Blood Culture (n = 6)

Table 8: Distribution of Isolates

Category	Number (n)	Percentage (%)
Gram-negative bacteria	4	66.7
Gram-positive bacteria	1	16.7
Candida spp.	1	16.7
Total	6	100.0

Gram-negative bacteria accounted for 66.7% of bloodstream isolates, whereas Gram-positive bacteria and fungal isolates each contributed 16.7%. This distribution demonstrates the predominance of Gram-negative pathogens in critically ill ICU patients.

Table 9: Antimicrobial Susceptibility of Gram-negative Isolates (n = 4)

Antibiotic	Sensitive n (%)
Colistin	4 (100.0)
Meropenem	3 (75.0)
Imipenem	3 (75.0)
Amikacin	3 (75.0)
Piperacillin–Tazobactam	2 (50.0)
Cefoperazone–Sulbactam	2 (50.0)
Ciprofloxacin	1 (25.0)
Ceftriaxone	1 (25.0)

Colistin demonstrated 100% susceptibility against all Gram-negative isolates. Meropenem, Imipenem, and Amikacin showed 75% susceptibility, whereas Piperacillin–Tazobactam and Cefoperazone–Sulbactam were effective against 50% of isolates. Ceftriaxone and Ciprofloxacin showed the lowest susceptibility (25%), indicating increasing resistance to commonly used antibiotics.

Table 10: Antimicrobial Susceptibility of Gram-positive Isolate (n = 1)

Antibiotic	Sensitive n (%)
Vancomycin	1 (100.0)
Linezolid	1 (100.0)
Clindamycin	1 (100.0)
Erythromycin	0 (0.0)
Penicillin	0 (0.0)

The single Gram-positive isolate was completely susceptible to Vancomycin, Linezolid, and Clindamycin, whereas resistance to Penicillin and Erythromycin was observed. These findings support the continued effectiveness of glycopeptides and oxazolidinones for serious Gram-positive bloodstream infections.

Table 11: Antifungal Susceptibility of *Candida* Isolate (n = 1)

Antifungal	Sensitive n (%)
Fluconazole	1 (100.0)
Voriconazole	1 (100.0)
Caspofungin	1 (100.0)
Amphotericin B	1 (100.0)

The Candida isolate demonstrated complete susceptibility to Amphotericin B, Caspofungin, Voriconazole, and Fluconazole, indicating preserved susceptibility to the commonly used antifungal agents.

Table 12: Resistance Pattern

Resistance pattern	Number (n)	Percentage (%)
ESBL-producing isolates	2	33.3
Carbapenem-resistant isolates	1	16.7
MRSA	0	0.0
Multidrug-resistant isolates	2	33.3

Among bacterial isolates, two (33.3%) were multidrug resistant and two (33.3%) were ESBL producers, while one isolate (16.7%) showed carbapenem resistance. No methicillin-resistant Staphylococcus aureus (MRSA) isolate was detected. These findings emphasize the importance of antimicrobial stewardship and routine surveillance for resistant pathogens.

Table 13: Clinical Outcome

Outcome	Number (n)	Percentage (%)
Recovered and discharged	35	70.0

Shifted to ward	7	14.0
Died	8	16.0
Total	50	100.0

Of the 50 patients, 35 (70%) recovered and were discharged, 7 (14%) improved sufficiently to be transferred from the ICU to the general ward, and 8 (16%) died. The observed mortality underscores the seriousness of bloodstream infections in critically ill patients and the need for prompt diagnosis and targeted antimicrobial therapy.

Out of the 50 blood culture samples, 6 (12%) yielded significant microbial growth, whereas 44 (88%) showed no growth. Among the six positive cultures, Gram-negative bacteria were the predominant isolates, accounting for 4 (66.7%) cases, while Gram-positive bacteria and Candida species accounted for 1 (16.7%) isolate each.

Among the culture-positive isolates, Klebsiella pneumoniae was the most frequently isolated organism, accounting for 2 (33.3%) isolates. Escherichia coli, Acinetobacter baumannii, Staphylococcus aureus, and Candida species were isolated from one patient (16.7%) each.

Antimicrobial susceptibility testing of the Gram-negative isolates demonstrated 100% susceptibility to Colistin, while Meropenem, Imipenem, and Amikacin each showed 75% susceptibility. Piperacillin–Tazobactam and Cefoperazone–Sulbactam were effective against 50% of Gram-negative isolates. The highest resistance was observed against Ceftriaxone and Ciprofloxacin, each showing susceptibility in only 25% of isolates. The single Gram-positive isolate (Staphylococcus aureus) was completely susceptible to Vancomycin, Linezolid, and Clindamycin, whereas resistance was observed to Penicillin and Erythromycin. The Candida isolate demonstrated complete susceptibility to Fluconazole, Voriconazole, Caspofungin, and Amphotericin B. Among the bacterial isolates, 2 (33.3%) were identified as extended-spectrum β-lactamase (ESBL)-producing organisms, 1 (16.7%) isolate was carbapenem resistant, and 2 (33.3%) isolates fulfilled the criteria for multidrug resistance (MDR). No methicillin-resistant Staphylococcus aureus (MRSA) or vancomycin-resistant Enterococcus (VRE) was isolated during the study period. Regarding clinical outcome, 35 (70%) patients recovered and were discharged from the hospital, 7 (14%) showed clinical improvement and were shifted from the ICU to the general ward, while 8 (16%) patients died despite appropriate supportive care and antimicrobial therapy.

Discussion

Bloodstream infections (BSIs) continue to be one of the leading causes of morbidity and mortality among patients admitted to intensive care units (ICUs). Early diagnosis, prompt initiation of appropriate antimicrobial therapy, and continuous surveillance of antimicrobial resistance are essential to improve patient outcomes. The present study was conducted to determine the microbiological profile and antimicrobial susceptibility pattern of bloodstream infections among ICU patients in a tertiary care hospital.

In the present study, the majority of patients belonged to the 46–60 years age group (36%), followed by patients aged 31–45 years (24%) and >60 years (24%). This finding is consistent with studies by Wisplinghoff et al.[8], Laupland[9], and Timsit et al.[11], who reported that bloodstream infections occur predominantly among middle-aged and elderly patients because of multiple comorbidities, prolonged hospitalization, invasive procedures, and age-related decline in immunity. Similar observations have also been reported in recent international studies, which demonstrated that increasing

age is an important risk factor for ICU-acquired bloodstream infections and poor clinical outcomes [19–21].

Male patients constituted 62% of the study population, while females accounted for 38%. Male predominance has also been reported by Bassetti et al. [1,16], Diekema et al. [10], and Rhodes et al. [3]. The higher incidence among males may be attributed to greater exposure to risk factors such as diabetes mellitus, chronic illnesses, smoking, trauma, and increased ICU admissions. Recent multicenter studies have also shown a higher frequency of bloodstream infections among male ICU patients [21,22].

In the present study, the Medical ICU contributed the highest number of suspected bloodstream infection cases (40%), followed by the Surgical ICU (24%). Similar observations have been reported by Wisplinghoff et al.[8] and Timsit et al. [11], who observed that critically ill medical patients frequently require prolonged ICU stay, invasive monitoring, and mechanical ventilation, predisposing them to bloodstream infections.

Among the 50 clinically suspected patients, blood culture positivity was observed in 12% of cases. The relatively low positivity rate in the present study may be explained by prior administration of broad-spectrum antibiotics before blood sample collection, collection of a single blood culture specimen, low-grade bacteremia, or infections caused by fastidious organisms. Similar observations have been reported by Lamy et al. [18], who emphasized that previous antibiotic exposure significantly reduces blood culture positivity. Studies by CDC-NHSN[12], WHO GLASS[4], and Antimicrobial Resistance Collaborators[13] also reported that blood culture positivity varies considerably depending on patient population, sampling technique, and laboratory methodology.

Among culture-positive isolates, Gram-negative bacteria (66.7%) predominated over Gram-positive bacteria (16.7%) and Candida species (16.7%). This finding is in agreement with studies by Diekema et al. [10], Bassetti et al. [1,16], and Timsit et al.[11], who also reported Gram-negative bacilli as the major pathogens responsible for ICU bloodstream infections. Recent global surveillance studies continue to demonstrate an increasing burden of multidrug-resistant Gram-negative organisms in tertiary care hospitals [13,19,21].

Among the isolated organisms, Klebsiella pneumoniae was the most common pathogen, followed by Escherichia coli, Acinetobacter baumannii, Staphylococcus aureus, and Candida species. Similar pathogen distribution has been reported by Wisplinghoff et al. [8], Diekema et al. [10], and Bassetti et al.[16]. Recent studies published during 2024–2025 have also identified Klebsiella pneumoniae as one of the leading causes of ICU-acquired bloodstream infections because of its increasing antimicrobial resistance and ability to acquire multiple resistance mechanisms [19–22].

Antimicrobial susceptibility testing demonstrated that Colistin showed 100% susceptibility among Gram-negative isolates, followed by Meropenem, Imipenem, and Amikacin. In contrast, Ceftriaxone and Ciprofloxacin exhibited poor susceptibility. Similar findings have been reported by Magiorakos et al. [6], Tacconelli et al. [17], and Bassetti et al. [16], who reported increasing resistance to third-generation cephalosporins and fluoroquinolones among Enterobacterales. The preserved activity of Colistin against multidrug-resistant Gram-negative organisms has also been demonstrated in several recent international surveillance studies [21–24]. However, indiscriminate use of Colistin should be avoided because emerging resistance has already been reported worldwide.

The single Staphylococcus aureus isolate in the present study remained susceptible to Vancomycin and Linezolid, while resistance to Penicillin was observed. Similar observations have been reported by CLSI [5], CDC-NHSN [12], and Tacconelli et al. [17], where glycopeptides and oxazolidinones continue to demonstrate excellent activity against Gram-positive pathogens.

The isolated Candida species showed complete susceptibility to Fluconazole, Voriconazole, Caspofungin, and Amphotericin B. Similar findings have been reported by Pappas et al. [15], although recent studies have highlighted the emergence of resistant non-albicans Candida species in critically ill patients, emphasizing the importance of routine antifungal susceptibility testing [15,25,26].

The present study identified ESBL-producing organisms in 33.3%, carbapenem resistance in 16.7%, and multidrug resistance in 33.3% of bacterial isolates. These findings correlate with reports by Magiorakos et al.[6], Antimicrobial Resistance Collaborators [13], and Tacconelli et al.[17], which describe antimicrobial resistance as one of the greatest threats to modern healthcare. Recent studies have similarly documented increasing prevalence of ESBL-producing and carbapenem-resistant Gram-negative bacilli in ICUs worldwide [21–26].

Regarding patient outcomes, 70% recovered, 14% improved sufficiently to be shifted from the ICU, and 16% died. Mortality associated with bloodstream infections depends on timely diagnosis, severity of illness, comorbid conditions, infecting organism, and adequacy of empirical antimicrobial therapy. Similar observations have been reported by Singer et al. [2], Rhodes et al. [3], Kumar et al. [7], and Paul et al. [14], who emphasized that delayed initiation of appropriate antimicrobial therapy significantly increases mortality in septic patients.

Overall, the findings of the present study are consistent with national and international literature, demonstrating that Gram-negative bacteria, particularly Klebsiella pneumoniae, remain the predominant pathogens causing bloodstream infections in ICU patients. The emergence of multidrug-resistant organisms further highlights the importance of continuous microbiological surveillance, antimicrobial stewardship programs, strict infection prevention measures, and periodic updating of hospital antibiotic policies to improve patient outcomes and reduce antimicrobial resistance.

Conclusion

The present study demonstrated that bloodstream infections remain an important cause of morbidity and mortality among patients admitted to intensive care units of a tertiary care hospital. Although the overall blood culture positivity rate was relatively low, Gram-negative bacteria were the predominant pathogens, with *Klebsiella pneumoniae* being the most frequently isolated organism. The study also identified the presence of multidrug-resistant, ESBL-producing, and carbapenem-resistant isolates, highlighting the growing challenge of antimicrobial resistance in critically ill patients.

Antimicrobial susceptibility testing showed that Colistin, carbapenems, and amikacin retained good activity against most Gram-negative isolates, while vancomycin and linezolid remained effective against Gram-positive organisms. The isolated *Candida* species was susceptible to all tested antifungal agents. These findings emphasize the importance of timely blood culture, accurate microbiological diagnosis, and antimicrobial susceptibility testing for the selection of appropriate empirical and targeted antimicrobial therapy.

Regular surveillance of the microbiological profile and antimicrobial resistance patterns, implementation of antimicrobial stewardship programs, strict infection prevention and control practices, and periodic revision of hospital antibiotic policies are essential to reduce the burden of bloodstream infections and improve clinical outcomes among ICU patients.

Limitations of the Study

1. The study was conducted at a single tertiary care hospital with a relatively small sample size (50 patients), which may limit the generalizability of the findings to other healthcare settings.
2. The low blood culture positivity rate may have been influenced by prior antibiotic administration before blood sample collection, resulting in false-negative culture results.
3. Molecular characterization of antimicrobial resistance mechanisms (such as ESBL, carbapenemase, or methicillin resistance genes) and advanced molecular identification techniques were not performed because of resource limitations.

References

1. Bassetti M, Righi E, Carnelutti A. Bloodstream infections in the intensive care unit. Virulence. 2016; 7(3):267-279. doi:10.1080/21505594.2015.1134072.
2. Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). JAMA. 2016;315(8):801-810.
3. Rhodes A, Evans LE, Alhazzani W, Levy MM, Antonelli M, Ferrer R, et al. Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016. Intensive Care Med. 2017;43(3):304-377.
4. World Health Organization. Global Antimicrobial Resistance and Use Surveillance System (GLASS) Report 2024. Geneva: World Health Organization; 2024.
5. Clinical and Laboratory Standards Institute. Performance Standards for Antimicrobial Susceptibility Testing. CLSI Supplement M100. 35th ed. Wayne (PA): CLSI; 2025.
6. Magiorakos AP, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, Giske CG, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: An international expert proposal for interim standard definitions. Clin Microbiol Infect. 2012;18(3):268-281.
7. Kumar A, Roberts D, Wood KE, Light B, Parrillo JE, Sharma S, et al. Duration of hypotension before initiation of effective antimicrobial therapy is the critical determinant of survival in human septic shock. Crit Care Med. 2006;34(6):1589-1596.
8. Wisplinghoff H, Bischoff T, Tallent SM, Seifert H, Wenzel RP, Edmond MB. Nosocomial bloodstream infections in US hospitals: Analysis of 24,179 cases from a prospective nationwide surveillance study. Clin Infect Dis. 2004;39(3):309-317.
9. Laupland KB. Incidence of bloodstream infection: A review of population-based studies. Clin Microbiol Infect. 2013;19(6):492-500.
10. Diekema DJ, Hsueh PR, Mendes RE, Pfaller MA, Rolston KVI, Sader HS, et al. The microbiology of bloodstream infection: 20-year trends from the SENTRY Antimicrobial Surveillance Program. Diagn Microbiol Infect Dis. 2019;93(3):195-204.
11. Timsit JF, Ruppé E, Barbier F, Tabah A, Bassetti M. Bloodstream infections in critically ill patients: An

expert statement. Intensive Care Med. 2020;46(2):266-284.

12. Centers for Disease Control and Prevention. National Healthcare Safety Network (NHSN) Patient Safety Component Manual. Atlanta (GA): CDC; 2024.
13. Antimicrobial Resistance Collaborators. Global burden of bacterial antimicrobial resistance in 2019: A systematic analysis. Lancet. 2022;399(10325):629-655.
14. Paul M, Shani V, Muchtar E, Kariv G, Robenshtok E, Leibovici L. Systematic review and meta-analysis of the efficacy of appropriate empiric antibiotic therapy for sepsis. Lancet Infect Dis. 2010;10(5):336-344.
15. Pappas PG, Kauffman CA, Andes DR, Clancy CJ, Marr KA, Ostrosky-Zeichner L, et al. Clinical Practice Guideline for the Management of Candidiasis: 2016 Update by the Infectious Diseases Society of America. Clin Infect Dis. 2016;62(4):e1-e50.
16. Bassetti M, Peghin M, Vena A, Giacobbe DR. Treatment of bloodstream infections caused by multidrug-resistant Gram-negative bacteria. Curr Opin Infect Dis. 2019;32(6):583-593.
17. Tacconelli E, Carrara E, Savoldi A, Harbarth S, Mendelson M, Monnet DL, et al. Discovery, research, and development of new antibiotics: The WHO priority list of antibiotic-resistant bacteria. Lancet Infect Dis. 2018;18(3):318-327.
18. Lamy B, Dargère S, Arendrup MC, Parienti JJ, Tattevin P. How to optimize the use of blood cultures for the diagnosis of bloodstream infections? Clin Microbiol Infect. 2016;22(Suppl 4):S27-S35.
19. Shorr AF, Tabah A, Lipman J. Bloodstream infection in the intensive care unit: Evolving epidemiology and microbiology. Antibiotics (Basel). 2024;13(2):174.
20. Holmes CL, Albin OR, Mobley HLT, Bachman MA. Bloodstream infections: mechanisms of pathogenesis and opportunities for intervention. Nat Rev Microbiol. 2025;23(4):210-224. doi:10.1038/s41579-024-01105-2.
21. Costa SP, Carvalho CM. Burden of bacterial bloodstream infections and recent advances for diagnosis. Pathog Dis. 2022;80(3):ftac027.
22. Santella B, Folliero V, Pirofalo GM, Serretiello E, Zannella C, Moccia G, et al. Sepsis: A retrospective cohort study of bloodstream infections. Antibiotics (Basel). 2020;9(12):851.
23. Rudd KE, Johnson SC, Agesa KM, Shackelford KA, Tsoi D, Kievlan DR, et al. Global, regional, and national sepsis incidence and mortality, 1990–2017: Analysis for the Global Burden of Disease Study. Lancet. 2020;395(10219):200-211.
24. Holmes CL, Anderson MT, Mobley HLT, Bachman MA. Pathogenesis of Gram-negative bacteremia. Clin Microbiol Rev. 2021;34(2):e00234-20.
25. Rasmussen M, Gilje P, Fagman E, Berge A. Bacteraemia with Gram-positive bacteria: When and how do I need to look for endocarditis? Clin Microbiol Infect. 2024;30(3):306-311.
26. Tong SYC, Fowler VG Jr, Skalla L, Holland TL. Management of Staphylococcus aureus bacteremia: A review. JAMA. 2025;334(9):798-808.